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PROGRAMMING for CALCOMP DIGITAL INCREMENTAL PLOTTERS

NOTICE

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I. GENERAL DISCUSSION OF PLOTTER PROGRAMMING

This bulletin describes the general techniques and methods of computer programming for CalComp Digital Incremental Plotters.

Six functions must be considered in order to obtain useful graphic output from the computer, although any specific application may not require the use of all six. The form of the graphic output obtained with these functions is restricted only by the size of the plotter and the ingenuity of the programmer. The six functions are:

1. PLANNING—In some cases, the planning function is accomplished in advance by the programmer. For example, in a simple graph of numeric data the programmer can easily decide the dimensions or positions of margins, heights, widths, labels, and data identifications. In other applications, it may be necessary for the computer to make these decisions on the basis of input data. A typical example is a PERT chart. The events can easily be located on the time axis, but the arrangement in the other axis must be based on the interrelationship of events, the number of events occurring at any point in time, and the prevention of task lines passing through events.
2. SCALING—For some problems, the range of data is predictable and the conversion factors can be set easily by the programmer. However, in the general case, the computer must scan the data to find maximum and minimum values. These values must then be scaled for optimum plot size and ease of interpolation between divisions.
3. LINE OR CURVE GENERATION—The magnitude and units of data must be converted to page dimensions. The data may then be presented as points, straight lines between adjacent points, or by curve fitting between points.
4. DATA IDENTIFICATION—The most common method of data identification is by means of axes. Each axis normally includes a title for the nature of the variable and its units of measurement, plus the magnitude of quantities evenly spaced along the axis.
5. LABELING—If the plot is affected by a third variable, data identification by means of axes may not be sufficient. Also, a plot may be valid only when identified by date or time. Thus, the ability to provide alphabetic or numeric labels is an essential function in the program.
6. SPECIAL FUNCTIONS—This category includes any special requirements not covered by the five functions described above. One of the most important special functions is the ability to change the reference point at the programmer's discretion. The three basic CalComp routines PLOT, SYMBOL, and NUMBER are highly flexible and most special functions can be provided by direct use of these routines by the programmer.

The CalComp package of subroutines provides all of the functions described above. All of the subroutines are written to permit ease of handling by the programmer, and can be implemented on a new computer in a short period of time. Your CalComp sales representative will be glad to note in the chart in Section V the availability of these routines for any particular computer.

II. DETAILED DESCRIPTIONS

A. SIGN CONVENTIONS

The sign conventions for CalComp plotter subroutines are designed for standard report-type graphs, with the vertical dimension designated as the Y-axis and the horizontal dimension as the X-axis. Standard graphs are usually presented on 8½ by 11 inch or 11 by 17 inch sheets. As shown in Figure 1, the Y-axis is plotted horizontally across the narrow dimension of the paper and the X-axis vertically along the long dimension. On some CalComp plotters, a switch is provided so that the X and Y axes may be interchanged at the discretion of the operator.

B. PLOTTING AREA

The plotting area on CalComp Digital Incremental Plotters depends upon the type and model number. Drum type plotters use chart paper rolls 120 feet in length with a plotting width (Y-axis) of either 11 inches or 29½ inches. Flatbed plotters have a plotting area of 31x34 inches or 48x72 inches.

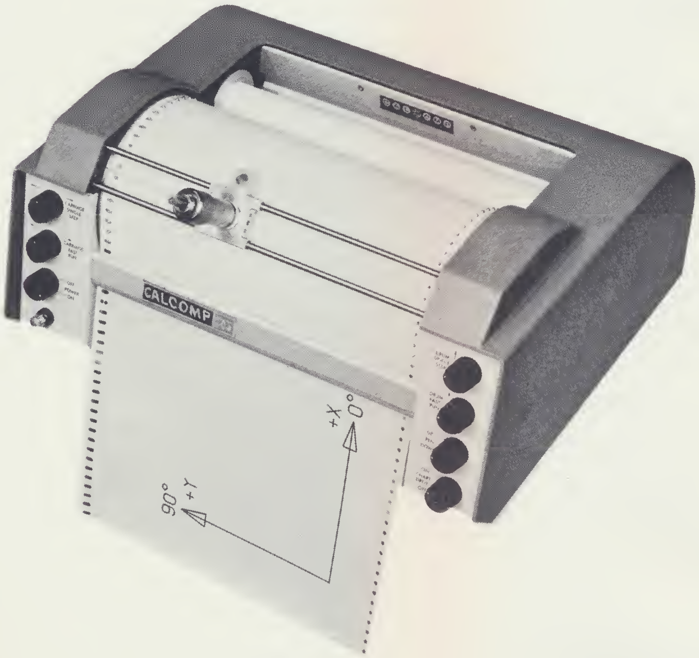

FIGURE 1
Sign Conventions, Shown on CalComp Model 565
Digital Incremental Plotter

C. CALCOMP PLOTTER SUBROUTINES

The following paragraphs describe the standard CalComp subroutines for the six programming functions discussed in Section I. Note that FORTRAN conventions are used in the argument list for each subroutine. Arguments starting with I, J, K, L, M or N are fixed point; all others are floating with the exception of ALPHA arrays, which are noted in the text.

1. PLANNING. Figure 2 illustrates a planning layout to program a series of graphs. This layout is taken from the planning for the graphs in the sample problem described in Section III of this bulletin.

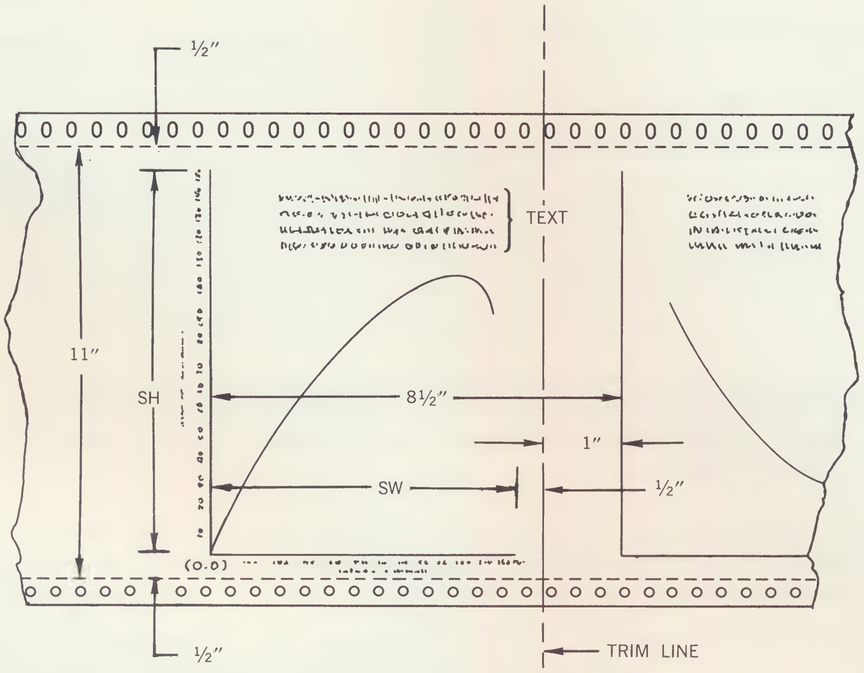

FIGURE 2
Planning Layout

2. SCALING. The SCALE routine finds maximum and minimum values and adjusts these to optimize the plot and establish scale values that are easy to interpolate between divisions.

```
CALL SCALE (ORD, SH, N, K)
CALL SCALE (ABS, SW, N, K)
```

ORD is the name of array containing the variable to be plotted as the ordinate.
ABS is the name of array containing the variable to be plotted as the abcissa.
SW is the maximum width of plotted line.
SH is the maximum height of plotted line.
N is the number of data points in each array.
K is the repeat cycle in case these values are in a mixed array. (Normally K = 1)

NOTE A

a. The adjusted ORD (minimum) and adjusted delta ORD ((maximum-minimum)/SH) are stored following the array of data. The adjusted minimum is stored in ORD (N*K+1) and delta in ORD (N*K+K+1). Similarly, these two values for ABS will be found in ABS (N*K+1) and ABS (N*K+K+1).

b. An additional optional argument DIV is allowed in some versions of SCALE to describe the type of paper to be used. For 10 divisions-per-inch, DIV = 10.0, and for centimeter paper DIV = 25.4.

3. LINE OR CURVE GENERATION. The LINE subroutine draws a line or symbol through each successive data point.

CALL LINE (ABS, ORD, N, K, J, L)

ORD, ABS, N, K. (See SCALE discussion above.)

J is used to control symbols placed on data points. J = 0 will produce only a line plot, J = 1 will produce a symbol at every data point, J = 2 will produce a symbol at every second data point, etc. A negative J suppresses the line between data points.

L is used to specify symbol to be used.

NOTE B

a. LINE requires the adjusted minimums and DELTA values as described in SCALE.

b. Symbols used for annotation by the LINE routine are the special centered symbols. See SYMBOL routine listing for symbol numbers.

4. DATA IDENTIFICATION. The AXIS subroutine draws a line with "tic" marks at one-inch intervals. It annotates the value of the variable at each of these tic marks and provides an axis identification label.

CALL AXIS (XO, YO, VORD, NCO, SH, THETA (O) , ORD (N*K+1), ORD (N*K+K+1))
CALL AXIS (XA, YA, VABS, NCA, SW, THETA (A), ABS (N*K+1), ABS (N*K+K+1))

(XO, YO) is the coordinate of the starting point of the ordinate axis.

(XA, YA) is the coordinate of the starting point of the abscissa axis.

VORD is the name of the alphabetic array of data for the ordinate axis title.

VABS is the name of the alphabetic array of data for the abscissa axis title.

NCO, NCA are the number of characters in each of the two axis titles. A minus sign places the annotation on the clockwise side of the axis instead of counterclockwise.

SH is the length of the ordinate axis.

SW is the length of the abscissa axis.

THETA (O),
THETA (A) are the angles (in degrees) of the ordinate and abscissa axes, respectively.

ORD (N*K+1) is the value of annotation at the first tic mark of the ordinate axis.

ORD (N*K+K+1) is the difference in an ordinate variable for a one-inch distance along the ordinate axis.

ABS (N*K+1) is similar to the ORD (N*K+1) description.

ABS (N*K+K+1) is similar to the ORD (N*K+K+1) description.

NOTE C

a. The last two arguments in the CALL AXIS are the same values computed by SCALE. (See SCALE description for more detail.)

b. The arguments SW and SH are usually the same values as the ones used in SCALE routine.

c. A ninth argument DIV may also be used as in SCALE. (See Note A.)

5. LABELING

CALL SYMBOL (X, Y, HEIGHT, BCD, THETA, NS)
CALL NUMBER (X, Y, HEIGHT, FPN, THETA, NN)

(X, Y) is the coordinate of the lower left corner of the first character to be drawn.
HEIGHT is the height of characters to be drawn.
BCD is the location of alpha array.
FPN is the floating point number.
THETA is the angle (degrees) at which the label is to be written.
NS is the number of characters in the label. A negative NS will produce a single centered character from the integer reference table and expects BCD to be an integer.
NN is the number of decimal digits to the right of the decimal point. A zero value will print the decimal point. A (-1) NN value will suppress the decimal point.

NOTE

On some computers NN will not be an integer. NN may assume any of the input/output formats in the form of a literal. For example: 2HI2 for I2 format. 4HF8.2 for an F8.2 format, etc.

6. SPECIAL FUNCTIONS. The basic plotting routine provides several entries. The first entry (off-line plot routines only) is to allocate a work region to the PLOT routine.

CALL PLOTS (BUFFER, NBUF)
CALL PLOTS (BUFFER, NBUF, NTAPE)

BUFFER is the low order core location of the work area.
NBUF is the number of words in work area.
NTAPE is the logical tape unit for output. (Some versions only; see PLOT listings for more detail.)

The second entry to PLOT is an instruction to move to the specified page coordinate with pen lifted or lowered. The third argument may also specify a new reference.

CALL PLOT (XPAGE, YPAGE, IC)

(XPAGE, YPAGE) is an instruction to the plot routine to generate the increments necessary to move pen from the current position to (XPAGE, YPAGE).
IC specifies pen up (3) or pen down (2). A negative IC provides a new reference point at (XPAGE, YPAGE) relative to current reference point.

A third entry is to assist in plotting optimization. This entry provides current plotter position.

CALL WHERE (XP, YP, FCTR)

(XP, YP) are filled with the current pen location upon return from the PLOT routine.
(FCTR) is current multiplying factor being used by PLOT. (See PLOT listings for details.)

Additional entries are available in several computer programs. Some of these entries provide factors, offsets and block addresses.